Mixing Zones for Persistent Bioaccumulative Toxic Substances

Dept. of Environmental Quality

Triennial Review Ad Hoc Advisory Committee

March 26, 2009

DEQ

VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

SWCB Directive

- *"3. Direct staff to reconvene the triennial review ad hoc advisory committee to ..... consider the need for a prohibition of any new or expanded mixing zones for persistent bioaccumulative toxic substances in § 9 VAC 25-260-20, General Criteria and Mixing Zones; and,....."*

A Primer on Mixing Zones in Virginia

VA Water Quality Standards

- *“"Mixing zone" means a limited area or volume of water where initial dilution of a discharge takes place and where numeric water quality criteria can be exceeded but designated uses in the water body on the whole are maintained and lethality is prevented.”*

VA Water Quality Standards

- Mixing zone concepts **may** be used in evaluating limits for VPDES permits
- No mixing zone shall….
  - substitute for minimum treatment technologies
  - violate the Federal Endangered Species Act of 1973 or the Virginia Endangered Species Act

VA Water Quality Standards

- Freshwater mixing zones evaluated or established by the board shall not….
  - prevent movement of or cause lethality to passing or drifting organisms through the water body in question
  - exceed 1/2 the width or 1/3 the cross section of stream
  - extend downstream at any time a distance more than 5X the stream width

VA Water Quality Standards

- Open ocean, estuarine and transition zone mixing zones evaluated or established by the board shall not….
  - prevent movement of or cause lethality to passing or drifting organisms through the water body in question
  - Extend more than 5X in any direction the average depth along a line extending 1/3 of the way across the receiving water from the discharge point to the opposite shore

VA Water Quality Standards

- *"A subsurface diffuser shall be required for any new or expanded freshwater discharge greater than or equal to 0.5 MGD to open ocean, estuarine and transition zone waters (see 9 VAC 25-260-140 C) and the acute and chronic criteria shall be met at the edge of the zone of initial mixing. The zone of initial mixing is the area where mixing of ambient water and effluent is driven by the jet effect and/or momentum of the effluent. Beyond this zone the mixing is driven by ambient turbulence."*

VA Water Quality Standards

- *"Mixing zones shall not be allowed by the board for effluents discharged to wetlands, swamps, marshes, lakes or ponds."*

VA Water Quality Standards (cont.)

- Acute WQS met outside allocated impact zone or zone of initial dilution
- Chronic WQS met at edge of mixing zone
- Spatial restrictions in streams and restriction on mixing zones in lakes and swamps may be waived if…..

1. Board determines complete mix is appropriate, or
2. Discharger provides acceptable demonstration of:
   a. actual boundaries of the mixing zone, and
   b. information and data demonstrating “zone of passage” and minimum treatment technology requirements are met.

VA Water Quality Standards (cont.)

- Acute WQS
  - 1-hour average concentrations
  - not to be exceeded more than 1/3 years
- Chronic WQS
  - 4-day average concentrations (30-day for NH_3)
  - not to be exceeded more than 1/3 years

VA Water Quality Standards (cont.)

- Unless statistically valid methods demonstrate compliance with duration and return frequency, steady state wasteload allocations calculated at the following stream flows:

Acute	1Q10
Chronic	7Q10
Chronic Ammonia	30Q10
Human Health	30Q5 (non-carcinogens)
Human Health	Harm. Mean (carcinogens)
Human Health Dioxin	Mean Annual

Conservative Assumptions

In the absence of statistically valid methods (e.g. Monte Carlo simulation) demonstrating compliance with the duration and return frequency of the WQC, steady state WLAs are calculated using.....

- Critical flows (1Q10, 7Q10, 30Q10, etc.)
- Design flow of the discharge

97th percentile of effluent concentrations is compared to WLA to determine “potential to exceed”

Conservative Assumptions

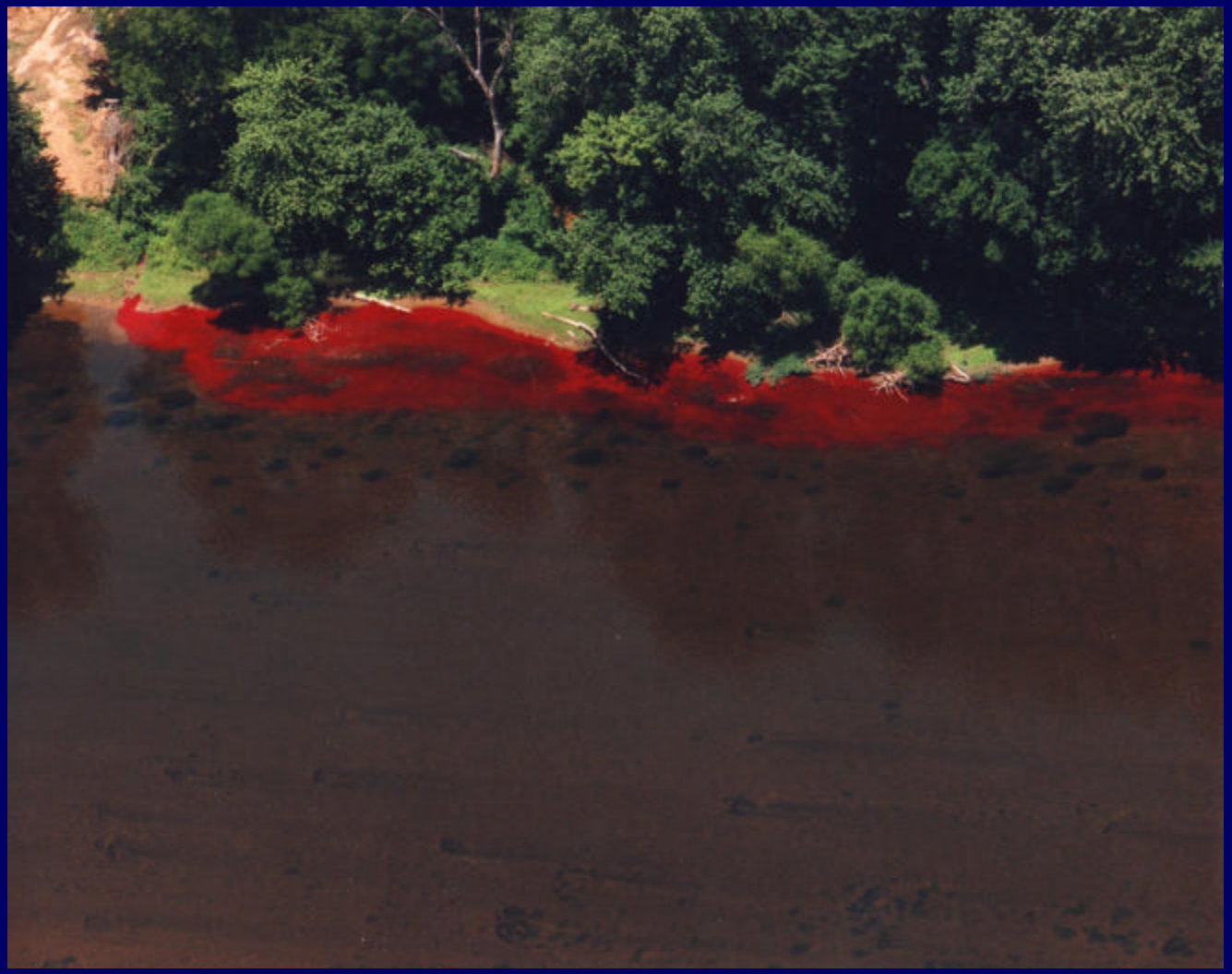
WQS Requirements			Wasteload Allocation Assumptions			
Criterion	Duration	Return Interval	Critical Stream Flow	Effluent Flow	Effluent Concentration	Return Interval
Acute WQC	1 hour	3 years	1Q10	Design Q	97th% of Daily Values	?
Chronic WQC	4 days	3 years	7Q10	Design Q	97th% of 4-day Avg	?
Chronic Ammonia WQC	30 days	3 years	30Q10	Design Q	97th% of 30-day Avg	?

Multiple conservative assumptions results in actual return frequencies much greater than 3 years.

Current Practice for Human Health

- Human Health WQC applied assuming a complete mix (or 50:1 in tidal waters) at average effluent concentrations, design flow and the following stream flows:
  - Human Health — 30Q5 (non-carcinogens)
  - Human Health — Harmonic Mean (carcinogens)
  - Human Health Dioxin — Mean Annual

Shore -based outfalls



Shore -based outfalls

Multi-port diffuser

Calculating WLA's for free flowing streams

- MIX.EXE model establishes conditions under which complete mix is appropriate.
- Duration of exposure is the key factor. MIX.EXE calculates % of stream effluent has mixed with after:
  - 1 hr. at 1Q10 for acute WQS
  - 2 days at 7Q10 for chronic WQS
- Resulting WLA's reduce effluent conc., if necessary, to ensure compliance with WQS duration and concentration requirements and allow passage of drifting organisms.

Calculating WLA's for lakes, marshes and swamps

- No mixing is the default
- WLA = WQS
  - WQS is met at the end of the pipe.
- Some exceptions have been granted for impoundments which are very large in comparison to the discharge and Regulatory Mixing Zone can be documented.

Calculating WLA's for tidal waters

- Duration of exposure not appropriate due to tidal action
- Spatial restrictions in WQS
- GM00-2011

  WLAa = 2x WQSa (2:1 mixing)
  WLAc = 50x WQSc (50:1 mixing)

  or

- Discharge is modeled and an alternative Regulatory Mixing Zone is established.
- Tidal vs. Tidal Freshwater

WLA's in areas considered to be critical habitat

- Mixing zones may be limited to the spatial restrictions listed in the VA Water Quality Standards
  - Freshwater - 1/2 stream width, 1/3 stream cross sectional area and length < 5x stream width
  - Transition, estuarine and open ocean – 5x water depth
  - Lakes, ponds, marshes & swamps - None
- Allocated impact zone may be limited to spatial restrictions in EPA's TSD for Water Quality-based Toxics Control .

So What About Persistent Bioaccumulative Toxics?

Persistent Bioaccumualtive Toxics

- Lots of definitions
- Lots of lists

Voluntary Mixing Zone Phase Out Strategy

Prepared by:

Chesapeake Bay Program's
Pollution Prevention and Point Source Workgroup
Of the Toxics Subcommittee

To Address:

The Zero Release Objective in the Chesapeake 2000 Agreement
and
The Mixing Zone Phase Out Goal in the Toxics 2000 Strategy

Draft Date: August 10, 2001

What is a PBT?

1. Persistent in the aquatic environment and having the potential to cause toxic impacts (certain metals),
2. Bioaccumulative to organisms in the aquatic environment and having the potential to cause toxic impacts, or
3. Being bioaccumulative and persistent in the aquatic environment while having the potential to cause toxic impacts to living resources (e.g. mercury and PCBs).

Source: August 10, 2001 draft report, *Voluntary Mixing Zone Phase Out Strategy*, Chesapeake Bay Program's Pollution Prevention and Point Source Workgroup of the Toxics Subcommitee

The following list of contaminants were selected based on the following criteria that was applied to the EPA's PBT list and the Chesapeake Bay Program's Chemicals of Concern list (appendix A):

A. Appearance on EPA's PBT list or Appendix A of the *Toxics 2000 Strategy's* Appendix A- Chemicals of Concern list.
B. Must be discharged by a point source and have a water quality standard.
C. The eight metals have been selected based on the Mixing Zone Task Force, work group expertise, and the Toxics Subcommittee input.
D. Must be either a persistent contaminant or bioaccumulative contaminant, or both
E. This list is only for data analysis purposes.

1. Mercury and its compounds
2. Lead and its compounds
3. Chromium
4. Copper
5. Arsenic
6. Cadmium
7. Nickel
8. Zinc
9. PAHs [1]
10. PCBs [2]
11. Hexachlorobenzene
12. dioxins and furans
13. Octachlorostyrene

While the following banned substances are recognized as persistent or bioaccumulative toxics, they are not expected to have a mixing zone. Thus they will not be included in this analysis:

Aldrin/Dieldrin	Chlordane	Toxaphene
Mirex	DDT, DDD, DDE	Kepone

Virginia WQ Impairments due to Potential PBTs

- Mercury and PCB's – 987 impairments (assessment units)
  - Mercury: 1,344 stream miles + 68 sq. miles (fish consumption)
  - PCBs: 1,021 stream miles + 2,176 sq. miles (fish consumption)
- Organics, Pesticides and PAHs – 21 impairments (asses. units)
  - Aldrin: 6.1 stream miles (fish consumption)
  - Chlordane: 1.6 stream miles (fish consumption)
  - 0.6 stream miles (aquatic life)
  - DDT and DDE: 19.4 stream miles (fish consumption)
  - Heptachlor expoxide: 14.2 stream miles (fish consumption)
  - Benzo(k)flouranthene: 0.7 sq. mile (fish consumption)
- Other Metals – 27 impairments
  - Cadmium: 5.4 stream miles + 26 acres (wildlife and/or aquatic life)
  - Copper: 10.2 stream miles + 574 acres (wildlife and/or aquatic life)
  - Lead: 12.5 miles + 26 acres (wildlife and/or aquatic life)
  - Zinc: 9 miles + 26 acres (wildlife and/or aquatic life)

Impairments due to Potential PBTs

- 1,035 PBT related impairments in VA
  - 1,007 fish consumption assessment units (Hg, PCBs, Organics, Pesticides and PAHs)
  - 17 aquatic life (Metals and 1 Chlordane)
  - 11 wildlife (Metals)
    - » All wildlife impairments also included as aquatic life impairments
  - 10 of 17 aquatic life impairments due to mining on Contrary Creek or the use of $CuSO_4$ to control algae in a drinking water supply

Are PBT impairments caused by mixing zones?

- Compliance with WQC instream while existing fish tissue criteria suggests a problem with the presumed bioaccumulation factor rather than allowance for mixing
- Many impairments due to legacy issues created prior to adoption of WQC rather than current practices

What would be the impacts of no mixing zones for PBTs on.....

- Human Health?
  - PBT discharges could be reduced from new and expanding dischargers
  - Are new and expanding facilities exacerbating the PBT problem?
  - Would instream PBT concentrations change?

What would be the impacts of no mixing zones for PBTs on.....

- Aquatic Life?
  - Aquatic Life WQC often much higher than Human Health WQC for PBT's
  - Few aquatic life PBT impairments in VA
  - Concern with mussels due to sessile nature and long life span
  - No mixing zone currently allowed for parameters for which aquatic life is impaired

What would be the impacts of no mixing zones for PBTs on.....

- Permitting Process?
  - Little experience with similar conditions in other states
  - Would “Pollutant Minimization Plan” adaptive management approach for PCBs be eliminated?
  - Limited data for PCBs and Hg using new low level test methods
  - Limited and/or expensive treatment options
  - No mixing zone currently allowed for discharges to water in which aquatic life criteria is violated
  - Perception that end-of-pipe limits will require extensive resources but make no measurable improvement in what is often a legacy issue

A potential permitting scenario.....

Expansion of a Major POTW on the Potomac River

- Existing POTW discharges to PCB impaired waters (Potomac River)
- Discharger proposes 5 MGD expansion
- Low level PCB monitoring shows that discharge is below the WQC but above the “end point” for the TMDL. A Pollutant Minimization Plan (PMP) is required in accordance with DEQ guidance.
- PCB load due to expansion represents < 1% of TMDL
- End of pipe limits required or may discharge expand and continue PMP?

A current scenario.....

St Paul WWTP/Dominion Power Wise

- Discharge of leachate from fly ash landfill
- Leachate recycled to the maximum extent possible
- Antidegradation Policy only allows for 10% of the remaining assimilative capacity of the stream to be used
- Current Mercury WQC met within 10 ft. of outfall but not end-of-pipe

Partial list of other states addressing PBTs

- New Jersey
  - no mixing zones for new discharges of 17 bioaccumulants
- Michigan
  - No mixing zones for new discharges of 22 Bioaccumulative Chemicals of Concern (BCCs)
  - No BCC mixing zones for existing discharge after 2010 – exceptions possible
- Colorado – may limit or deny mixing zone when bioaccumulation is likely

What alternatives do we have?

- Modify WQS to eliminate new or expanding mixing zones for PBTs
- Revise guidance to eliminate new or expanding mixing zones for PBTs
- Revise WQS to limit PBT mixing zones for new or expanding facilities to the regulatory mixing zone in 9 VAC-25-26020.B.1.
- Revise guidance to limit PBT mixing zones for new or expanding facilities to the regulatory mixing zone in 9 VAC-25-26020.B.1.
- No action
- Others alternatives?

Discussion